

EXPLANATION OF PLATE 49.

- Fig. 1. Head of *Ceratocheilus Winn-Sampsoni*, Wesché, ♂.
 2. End of proboscis of *C. Winn-Sampsoni*, highly magnified and seen from the dorsal side.
 3. Plate covering the base of the labium of same insect.
 4. End of proboscis of *C. longirostris*, Wesché, highly magnified and seen from the ventral side.
 5. Wing of *Neoceratocheilus Grahmi*, Wesché.
 6. Wing of *C. Winn-Sampsoni*.
 7. Wing of *C. longirostris*.
 8. Antenna of *C. Winn-Sampsoni*, ♂.
 9. Antenna of *C. Winn-Sampsoni*, ♀.
 10. Antenna of *C. longirostris*, ♂.
 11. Bifid hair of leg found on the species of *Ceratocheilus*.

Freshwater Rhizopods from the English Lake District. By JAMES
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(PLATE 50.)

[Read 18th November, 1909.]

FOR the purpose of studying the variation and distribution of Freshwater Rhizopods, collections were made from various localities in the English Lake District. Though only a small area was explored, some interesting results have been obtained. The material, which consisted partly of collections of sphagnum and other bog-mosses, and partly of sediment and vegetation from tarns and lakes, was brought home and carefully washed and examined.

About 50 species of Rhizopods were identified, many of them common and familiar forms, but others, again, are less well known, while a few do not seem to have been recorded from this country. Among these, *Paulinella chromatophora*, Lauterborn, is of interest, having been found in only a few places on the Continent and in N. America, and only as a single specimen from Loch Ness in Scotland.

Naturally, many of the specimens found were empty tests, notably those of species of *Diffugia*, *Euglypha*, *Assulina*, and *Trinema*, but in most cases active individuals also occurred.

It will be seen that some species—e. g., *Diffugia oblonga* (= *D. pyriformis*), *D. constricta*, *Centropyxis aculeata*, *Nebela collaris*, *Quadrula symmetrica*, *Cyphoderia ampulla*, *Euglypha alveolata*, and *Trinema enchelys*—occur in all or nearly all the collections examined. This is probably due to the fact that,

List of Species.	WESTMORLAND.			CUMBERLAND.					
	1	2	3	4	5	6	7	8	9
NEBELINA (<i>cont.</i>).									
<i>Nebela flabellulum</i> , <i>Leidy</i>	×	×	×
„ <i>dentistoma</i> , <i>Penard</i>	×	×	..	×	..	×
<i>Quadrula symmetrica</i> (<i>Wallich</i>), <i>Schulze</i>	×	×	×	×	..	×	×	..	×
<i>Heleopera petricola</i> , <i>Leidy</i>	×	×	..	×	×	..	×
<i>Cochliopodium bilimbosum</i> (<i>Auerb.</i>), <i>Leidy</i>	×	×	..
EUGLYPHINA.									
<i>Euglypha alveolata</i> , <i>Dujardin</i>	×	×	×	×	×	×	×
„ <i>ciliata</i> (<i>Ehrenb.</i>), <i>Leidy</i> ..	×	..	×	×
„ <i>strigosa</i> (<i>Ehrenb.</i>), <i>Leidy</i>	×
„ <i>compressa</i> , <i>Carter</i>	×	×	×	×
<i>Placocysta spinosa</i> (<i>Carter</i>), <i>Leidy</i> ..	×
<i>Assulina seminulum</i> , <i>Ehrenb.</i>	×	×	×	×	×
<i>Cyphoderia ampulla</i> (<i>Ehrenb.</i>), <i>Leidy</i> ..	×	×	×	..	×	×	×	×	×
<i>Trinema enchelys</i> (<i>Ehrenb.</i>), <i>Leidy</i> ..	×	×	×	×	×	×	×	×	×
„ <i>lineare</i> , <i>Penard</i>	×	×	×	×	×	..
<i>Corythion dubium</i> , <i>Taránek</i>	×	×	×
<i>Sphenoderia lenta</i> , <i>Schlumb.</i>	×	×	..	×	×	..	×	..	×
<i>Paulinella chromatophora</i> , <i>Lauterb.</i>	×
GRÖMLINA.									
<i>Microgromia socialis</i> , <i>Archer</i>	×	..

with the exception of Esthwaite Lake and Windermere, all the situations may receive drainage from sphagnum.

The following material was examined :—

1. Sphagnum taken from the moorlands above Easedale Tarn.
2. Vegetation (especially *Isoëtes*) and sediment from Easedale Tarn.
3. Scrapings from the surface of submerged stones in Blea Tarn (Little Langdale).
4. Sphagnum from the head of Tilberthwaite Gill.
5. Sphagnum and other bog-mosses from Yewdale (Coniston).
6. Vegetation from a stream entering “Highlow” Tarn (Tarn Hows), Coniston.
7. Vegetation and sediment from “Highlow” Tarn.
8. Vegetation and sediment from the western margin of Esthwaite Lake.
9. Vegetation and sediment from the western margin of Windermere.

Remarks on some of the Species.

AMŒBA VESPERTILIO, Penard, 'Faune rhizopodique du Bassin du Léman,' 1902, p. 92. (Plate 50. figs. 1 & 2.)

Though it is doubtful whether all the various forms of *Amœba* described by different authors are really distinct species, it seems to me that *A. vesper-tilio* is quite characteristic. I have found it, not only in Esthwaite Lake, but also in sediment from near Sheffield, and always having the same features. It is somewhat variable in form, but during movement always possesses a broad clear belt of ectoplasm in front, from which arise the characteristic sharp-pointed cone-shaped pseudopodia. The endoplasm is fairly granular and contains various inclusions, mostly food-bodies (Algæ). There are generally several vacuoles which tend to flow together, forming a large one. The nucleus is single, slightly oval, with a central mass of chromatin matter ("nucleolus") surrounded by a clear border. Size about 50 μ .

DIFFLUGIA RUBESCENS, Penard, 'Rocky Mountain Rhizopods,' in 'American Naturalist,' 1891; 'Faune rhizopodique &c.,' p. 227. (Plate 50. figs. 3, 4, 5.)

This species does not seem to have been recorded for this country before. The test is pyriform in outline, but shorter in proportion than that of *D. oblonga* (= *pyriformis*). It is transparent, consisting of thin flakes and broken diatom frustules. The neck is almost uniform in width and quite distinct. Within the margin of the mouth a series of blunt tubercles or tooth-like projections is to be noted (see fig. 4). This character is not mentioned by Dr. Penard, but all my specimens, whether collected in the Lake District or near Sheffield, showed it. The protoplasm does not nearly fill the test and is attached to the fundus by several clear epipodes. When the animal is active the protoplasm projects from the test as a distinct column, from which one, or occasionally two, finger-like pseudopodia arise.

A characteristic feature is the presence of numerous round, brick-red granules in the endoplasm, especially in the region towards the mouth. They are always present, and when the animal is extended they project to the origin of the pseudopodia, or even into them for a short distance. The nucleus is single and distinctly seen. Size 80 μ in length by 55 μ in breadth.

DIFFLUGIA LANCEOLATA, Penard, in 'Mém. Soc. phys. et hist. nat. Genève,' 1890; 'Faune rhizopodique &c.,' p. 250.

Associated with *D. oblonga* one often meets with individuals belonging to this species. The character and shape of the test readily distinguish it, being lanceolate and not pyriform, with generally a rounded, but occasionally a bluntly-pointed, fundus. There is no indication of a neck. The test is covered with thin flakes and rarely carries large grains, so that the outline is uniform. Size 146-160 μ in length.

DIFFLUGIA CONSTRICTA (Ehrenb.); Leidy, 'Freshwater Rhizopods of North America,' 1879, p. 120; Penard, 'Faune rhizopodique &c.,' p. 298.

This appears to be one of the commonest and most widely distributed of the genus, occurring in almost all kinds of situations. It is very variable in size, ranging from $64\ \mu$ to $100\ \mu$. Its shape, also, is most variable. It always, however, has an obliquely-placed mouth with inverted margin, a swollen posterior fundus, and flattened anterior end. The test is always covered with stones.

DIFFLUGIA OVIFORMIS, Cash, 'British Freshwater Rhizopoda & Heliozoa,' vol. ii. 1909, p. 52, pl. 20. figs. 8-12. (Plate 50. figs. 6, 7, & 8.)

In Easedale Tarn numerous empty tests occurred belonging to this species, which was discovered by Cash in ponds at Chelford (Cheshire). The test is somewhat oval in shape, nearly twice as long as broad, with regularly curved outline. Anteriorly it is abruptly truncated by the borders of the wide mouth. Surrounding the mouth is a very prominent collarette, which in side view gives the appearance of a much-thickened rim. The mouth itself is very prominently and regularly 4-lobed (several specimens showed 5 lobes). The lobes are very regularly rounded, and separated by as many pointed prominences, appearing in side view as notches on the collarette. The test is distinctly brownish yellow and opaque, and is covered with irregularly shaped yellow flakes with very distinct brownish cementing substance between, appearing as brown punctated veins traversing the surface of the test. Unfortunately, none of the specimens were active and the characters of the protoplasm were not observed.

Size $86\ \mu$ long by $45\ \mu$ broad (Cash gives the size as $110\ \mu$ long by $80\ \mu$ broad).

D. oviformis appears most nearly related to *D. limnetica*, Levander, and *D. gramen*, var. *achlora*, Penard. With these two forms it agrees in the characters of the test and in the presence of the collarette, but differs in size and shape and in the shape and lobing of the mouth.

PONTIGULASIA VAS (Leidy); Schouteden, in 'Ann. Biol. Lacustre,' i. 1906, p. 338, note.

Typical examples of this species, which is the *Diffugia pyriformis*, var. *vas*, of Leidy ('Freshwater Rhizopods of N. America'), were found in Esthwaite Lake. Size $150\ \mu$. Dr. Penard ('Faune rhizopodique &c.,' p. 348) describes this form under the name *P. spectabilis*.

PONTIGULASIA COMPRESSA (Carter); Cash, 'British Freshwater Rhizopoda & Heliozoa,' vol. ii. p. 61.

In Easedale Tarn, and also in sediment collected near Sheffield, I have found active examples which, while obviously belonging to this species, are sufficiently large and broad to be identified with the form described by

Dr. Penard ('Faune rhizopodique &c.,' p. 322) as *P. bigibbosa*. This latter, now a variety of *P. compressa* (*P. compressa*, var. *bigibbosa*), Penard regards as occurring only in large lakes.

Size: length 250 μ , width 200 μ , depth 160 μ . Cash gives for *P. compressa*, length 130–150 μ , breadth 100 μ ; while Penard gives for *P. bigibbosa*, length 250 μ .

NEBELA BOHEMICA, Taránek, 'Monographie der Nebeliden Böhmens' (in *Abhand. der kön. Böhm. Gesell. Wiss.*, 1882), p. 34; Penard, 'Faune rhizopodique &c.,' p. 351.

Amongst collections containing *N. collaris* in quantity, a form frequently occurs which appears to be this species. Compared with *N. collaris* it is somewhat broader in proportion. The borders of the mouth appear straight in the broad view of the test, and without the lateral notches characteristic of *N. collaris* in narrow view. Further, a distinct area surrounding the mouth is without the covering of plates and appears as a clearly defined, but not thickened lip. Its size varies up to 128 μ in length by 77 μ in breadth.

NEBELA MILITARIS, var. TUBULATA, var. nov. (Plate 50. figs. 9 & 10.)

This variety is occasionally found amongst sphagnum, but never in large numbers. I have met with it, not only in this district, but also near Sheffield. The test is generally very regular in form, and has the shape of a somewhat compressed round-bottomed flask with prominent neck, which is of uniform width throughout and about one-half the total length of the test. The mouth is bordered by prominent "lips" with thickened margins, convex in broad view of the test, and showing a distinct notch in narrow view. The surface structure is like that of typical forms of *N. militaris*.

Size: length 64 μ , breadth 32 μ , length of neck about 32 μ .

The relationship of this form is rather doubtful, and at present it seems best to regard it as a variety of *N. militaris*, Penard. The general shape suggests *N. lageniformis*, Penard, and *N. barbata*, Leidy. From these, however, it differs distinctly, not only in size, being very much smaller, but also in the characters of the mouth and lips, in which respects it approaches *N. militaris*. From typical examples of this last, again, it is readily distinguished by its general shape, the characteristic parallel-sided neck, and slighter build.

HELEOPERA PETRICOLA, Leidy, 'Freshwater Rhizopods of N. America,' p. 165; Penard, 'Faune rhizopodique &c.,' p. 382.

This species occurs very commonly in sphagnum. Many of the specimens found exhibit the violet colour mentioned by Penard.

EUGLYPHA COMPRESSA, *Carter*, in 'Annals & Mag. of Nat. Hist.,' 3rd ser., xiii. & xv. ; *Penard*, 'Faune rhizopodique &c.,' p. 507. (Plate 50. figs. 11 & 12.)

Besides the features characterising this species, *i.e.* the very compressed nature of the test and the form of the plates, the presence of spines of special form is of interest. These spines are particularly long and prominent, averaging about 20μ in length. They arise from the intervals between consecutive plates around the lateral margin of the fundus of the test. Each has the shape of a flattened blade tapering towards the free extremity, and narrowing more suddenly towards the base, where it enlarges abruptly to form the button-like structure by which it is held to the test. They arise generally in groups of two or three. They are quite different from the spines of *E. alveolata*, in which species they arise as outgrowths of the plates themselves, and also from the "cilia" of *E. ciliata*.

One example from Easedale Tarn was of particular interest. It appeared to be in the stage preparatory to division. The protoplasm contained many plates ready for the formation of the daughter test, and these were, at any rate in part, arranged definitely in position with reference to their relative places in the new test. This was especially seen in the toothed plates which surround the "mouth." Ten toothed plates, five above and five below, were seen lying side by side near the end of the fundus. Beyond these, ordinary oval plates were visible, alternating with them; while lying between them were the large spines with pointed ends towards the mouth of the old test. It thus appears as if the plates and spines for the new test are to some extent arranged before the daughter protoplasm passes out from the old test. Unfortunately the process of division did not seem to be completed.

PLACOCYSTA SPINOSA (*Carter*); *Leidy*, 'Freshwater Rhizopods of N. America,' p. 221.

This species is very characteristic and is readily distinguished from the *Euglyphas* by the absence of teeth on the plates surrounding the mouth. The spines, however, are very similar in character to those of *Euglypha compressa*. It seems to be rarely met with, although it is also recorded by Prof. G. S. West from Bowness (Westmorland) and from Hawkshead (Lancashire) in this district.

Size : length 145μ , breadth 100μ .

TRINEMA LINEARE, *Penard*, in 'Mem. Soc. phys. et hist. nat. Genève,' 1890; & 'Faune rhizopodique &c.,' p. 529.

This form appears quite distinct from *T. enchelys*. It is uniformly longer and narrower in proportion and more tube-like, with the mouth obliquely placed across the narrower end, and not so distinctly ventral as in *T. enchelys*.

Size : up to $25\mu \times 9\mu$.

CORYTHION DUBIUM, *Taránek*, 'Monographie der Nebeliden Böhmens, &c.,' p. 43; *Penard*, 'Faune rhizopodique &c.,' p. 531. (Plate 50. figs. 13 & 13 a.)

This species seems to be generally overlooked or confused with *Trinema enchelys*, from which, however, it differs in the construction of the test. This consists of narrow oval plates somewhat irregularly arranged and difficult to see; while in *T. enchelys* the plates are round, and, at any rate in the larger forms, of two sizes, the intervals between the larger ones being filled up by the smaller ones, giving the characteristic beaded appearance to the margins of these plates.

Size $32 \mu \times 22 \mu$.

PAULINELLA CHROMATOPHORA, *Lauterborn*, 'Protozoënstudien,' in 'Zeitschr. f. wiss. Zool.,' Bd. 59, 1895, p. 537; *Penard*, 'Revue suisse de Zool.,' 1905. (Plate 50. figs. 14 & 15.)

This species has been reported from Loch Ness in Scotland (a single individual), but, so far as I have been able to discover, not from this country previously. It occurs in Highlow Tarn, but all the individuals I found were empty tests. These, however, correspond with *Penard's* description. The test is regular and oval in shape, terminating in a short collar surrounding the elliptical mouth; it is formed of five longitudinal rows of rectangular plates with rounded ends, there being about 12 plates in each row, placed in alternating series.

Size: from 27 to 32 μ long and from 20 to 23 μ broad.

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LITERATURE.

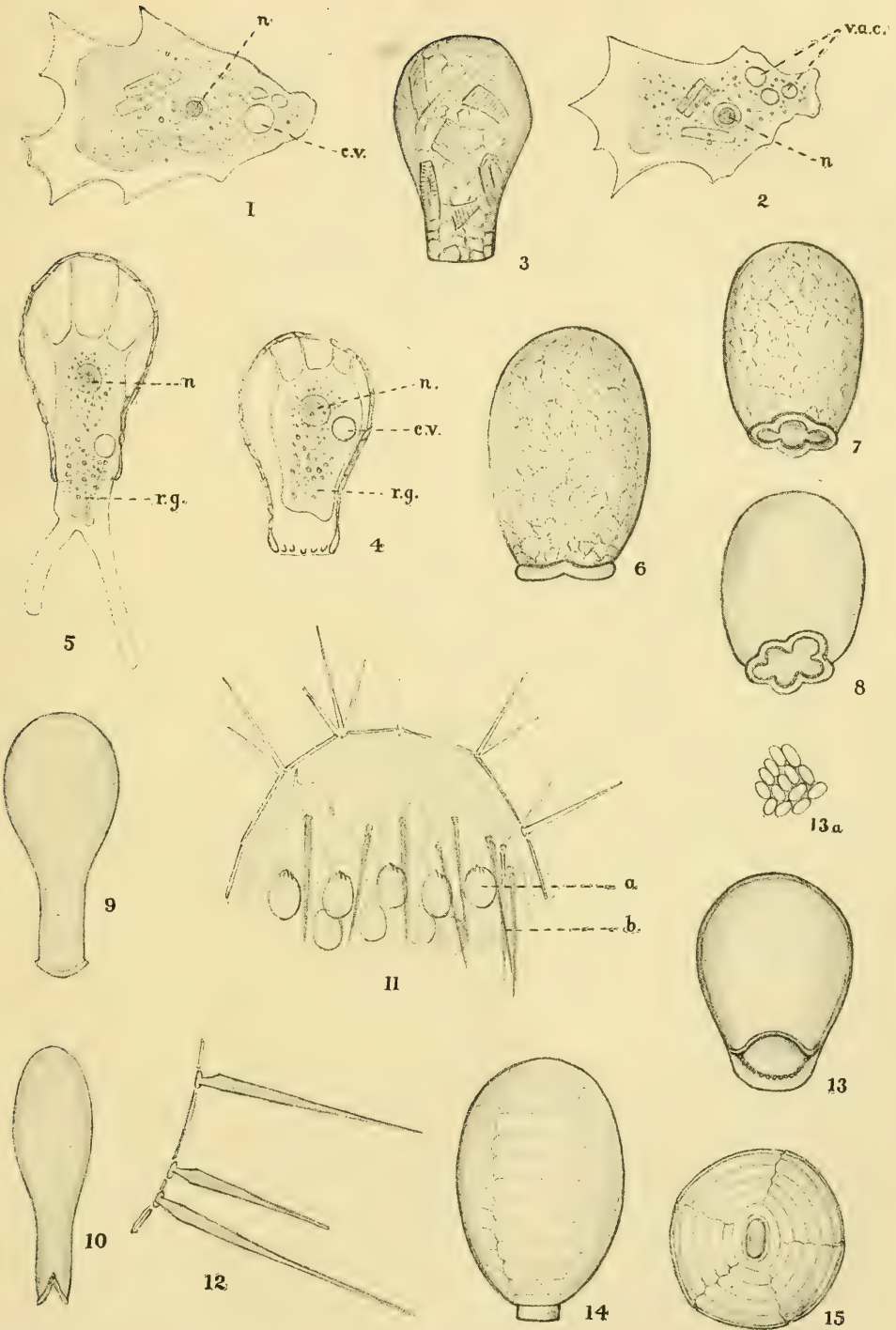
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EXPLANATION OF PLATE 50.

- Figs. 1 & 2. *Ameba vespertilio*, Penard. $\times 500$. Active individuals. *n.*=nucleus, *c.v.*=contractile vacuoles, *vac.*=vacuoles.
- Figs. 3-5. *Diffugia rubescens*, Penard. $\times 400$. Fig. 3 is a surface view of the test. Fig. 4 is an optical section of an individual retracted. Fig. 5 is the same of an active individual. *n.*=nucleus, *c.v.*=contractile vacuole, *r.g.*=red granules.
- Figs. 6-8. *Diffugia oviformis*, Cash. $\times 400$. Figs. 6 & 7 are different views of typical examples. Fig. 8 shows an individual with a somewhat irregularly 5-lobed mouth.
- Figs. 9 & 10. *Nebela militaris*, var. *tubulata*, var. nov. $\times 600$. Fig. 9 is the broad view and fig. 10 the narrow view of an empty test.
- Figs. 11 & 12. *Euglypha compressa*, Carter. Fig. 11 shows a portion of an individual with mouth-plates (*a*) and spines (*b*) of the daughter animal. $\times 600$. Fig. 12 shows the spines of a typical individual. $\times 1000$.
- Fig. 13. *Corythion dubium*, Taránek. $\times 1000$. Surface view of an empty test. Fig. 13 *a* shows the arrangement of the plates.
- Figs. 14 & 15. *Paulinella chromatophora*, Lauterborn. $\times 1000$. Fig. 14 is an empty test in side view. Fig. 15 is the same seen from the oral end.



J. M. B. del.

Grout, sc.

FRESHWATER RHIZOPODS.